Status of the ITER FW&S Design

Conceptual Design

May 11, 2005

M. Ulrickson
Presented at PFC Technology Meeting
At PPPL

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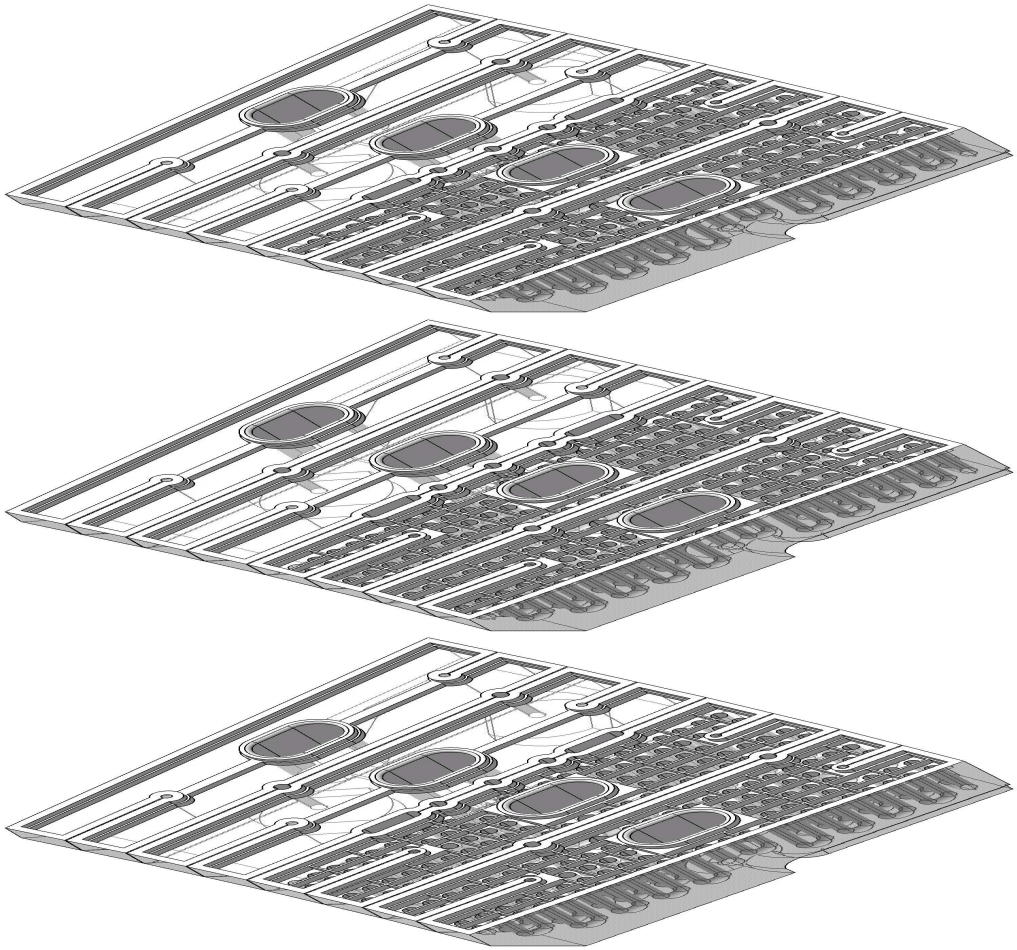
Outline

- Shield Module
  - Physical layout
  - Thermal Analysis
  - Electromagnetic Analysis
- First Wall
  - Physical layout
  - Thermal Analysis
  - Electromagnetic Analysis
- Issues to be resolved

Shield-layout



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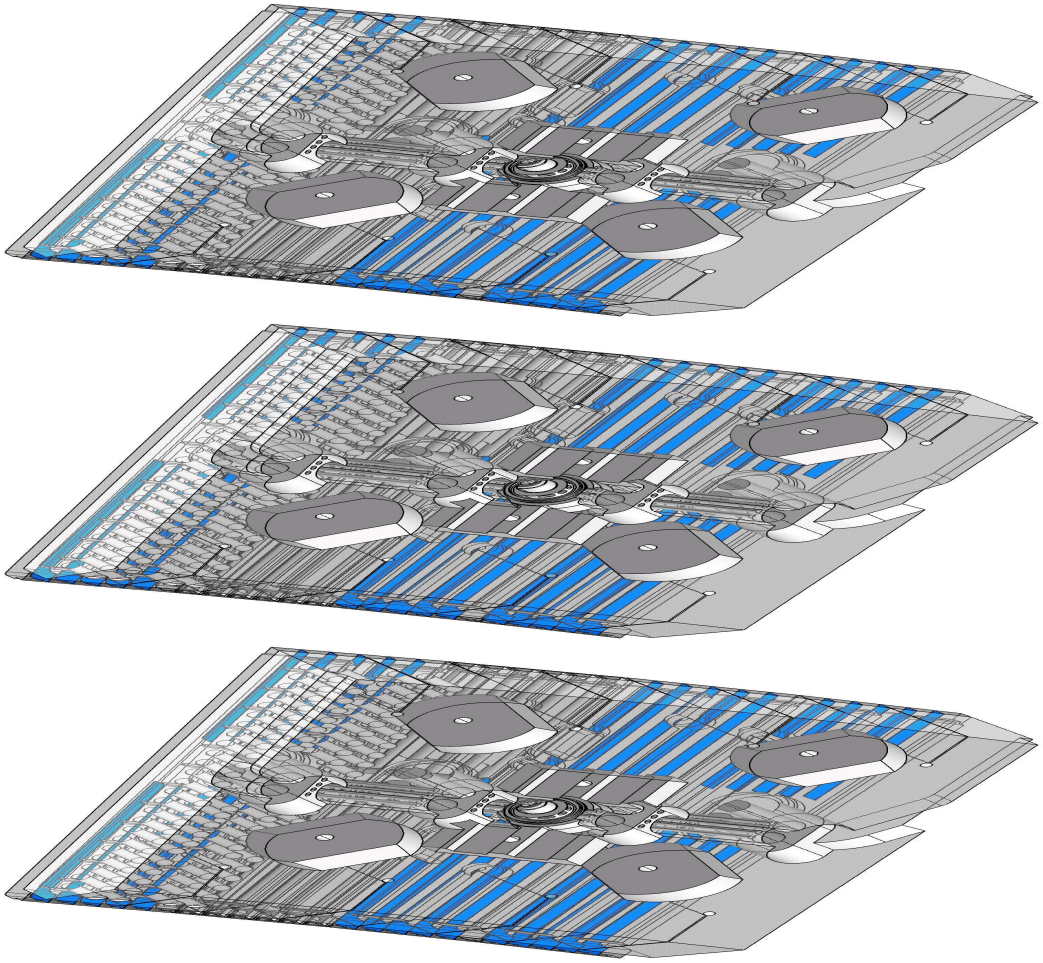
Shield-layout



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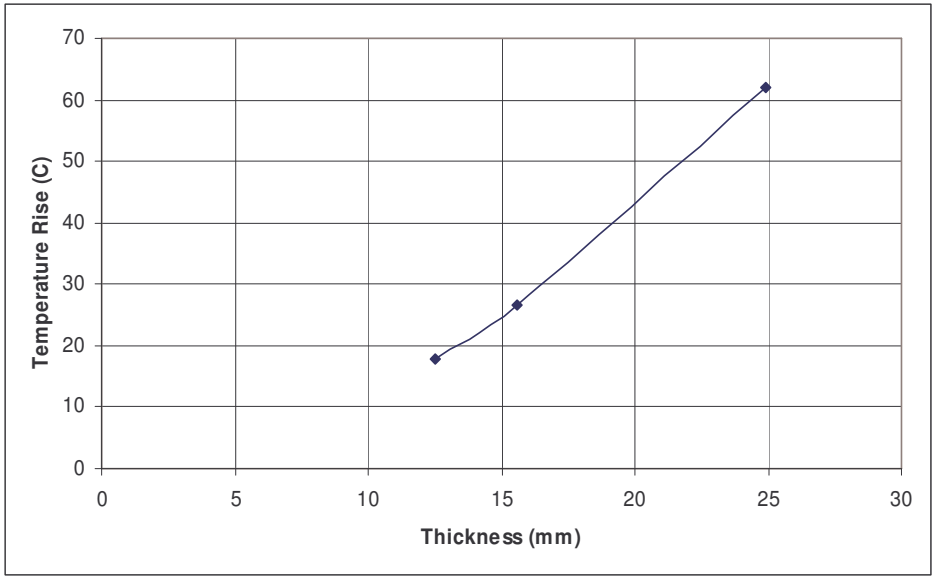
Shield Thermal Analysis

- Temperature rise due to nuclear heating has been calculated with 3.6 W/cm3
- The temperature rise in the stainless is only due to nuclear heat
- A delta T of about 16 C over 4 mm is sufficient to cause stresses of about yield in 316 LN Steel



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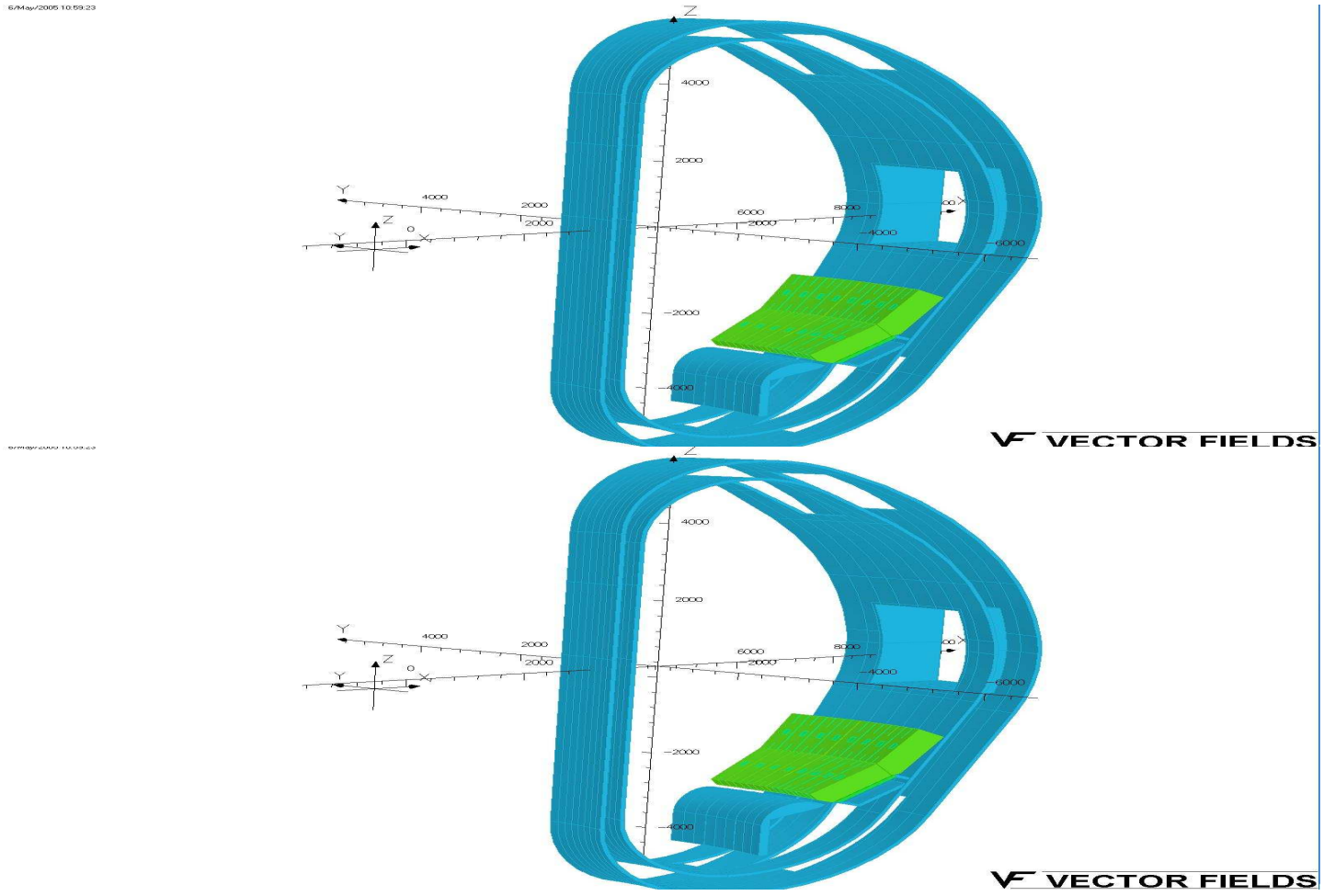
Shield EM Analysis

- A complete 20 degree sector of the vacuum vessel, ports, lower triangular support, module 18 and 17, and the divertor was constructed in OPERA. PF coils were included. TF simulated by a single wire.
- Two disruption cases were provided by IT
  - An 18 ms exponential current decay vertical disruption
  - A 40 ms linear decay VDE

Vessel, Shield and Divertor



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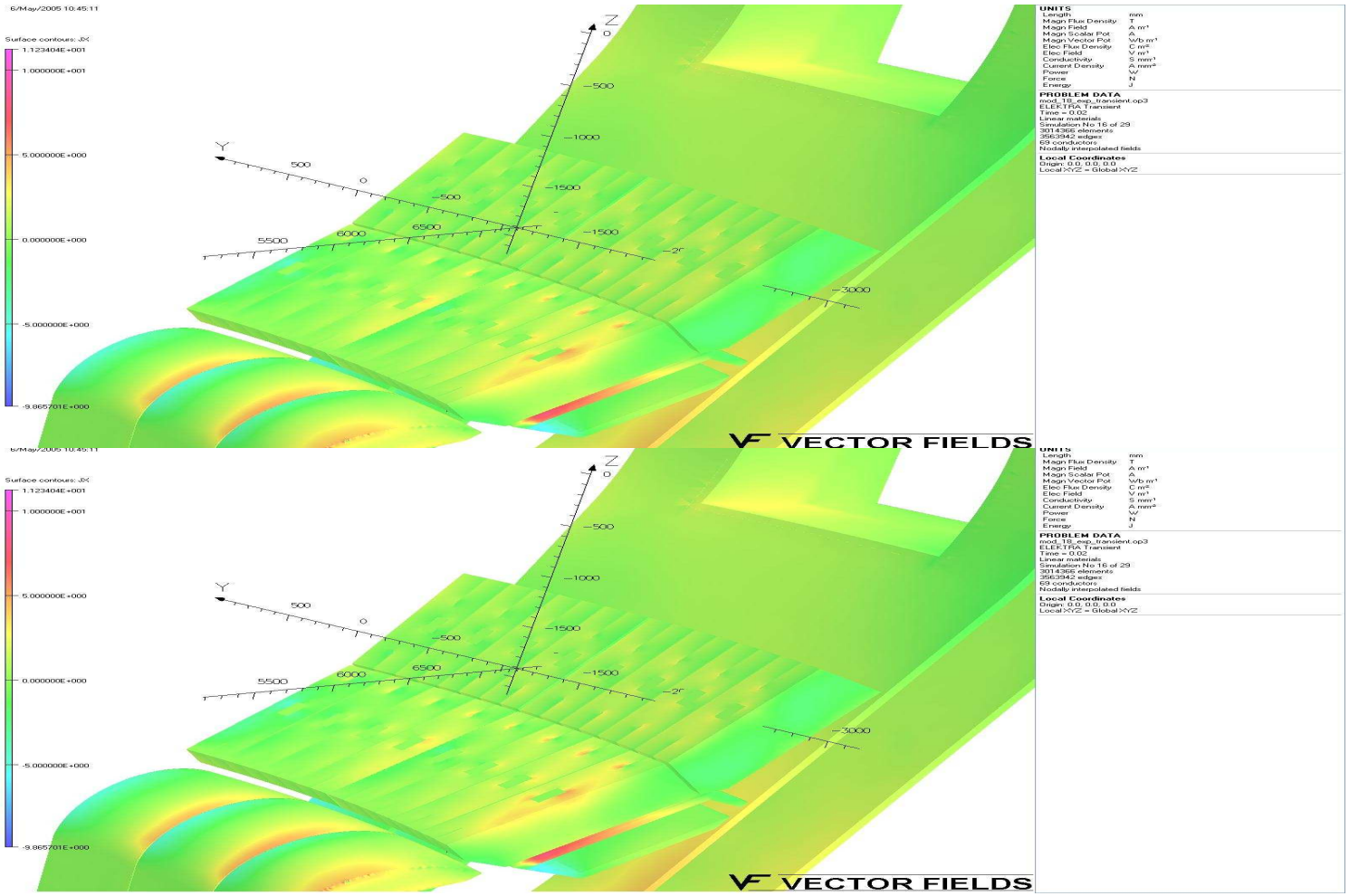
Shield Current (Preliminary)



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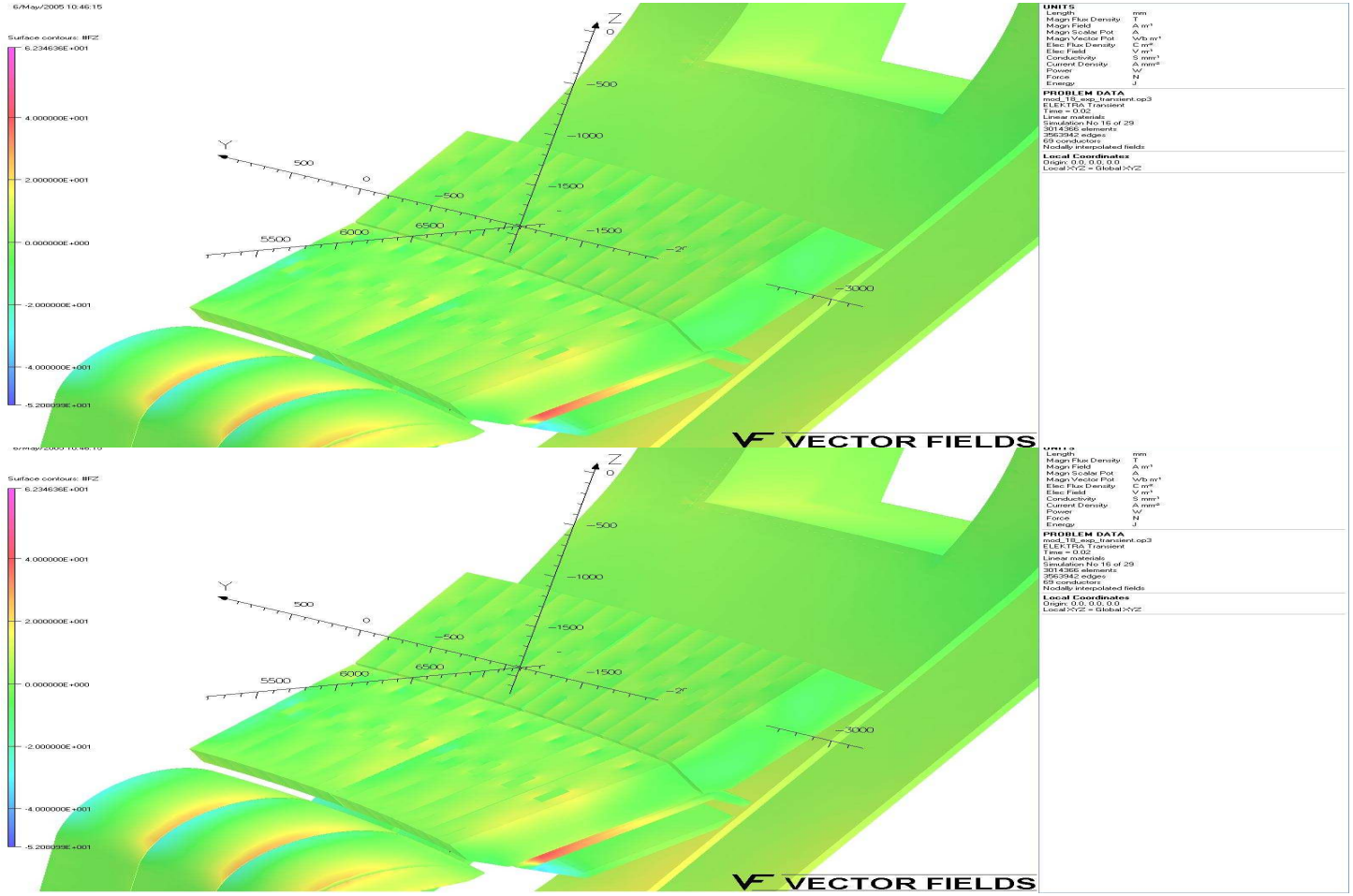
Shield Forces (Preliminary)



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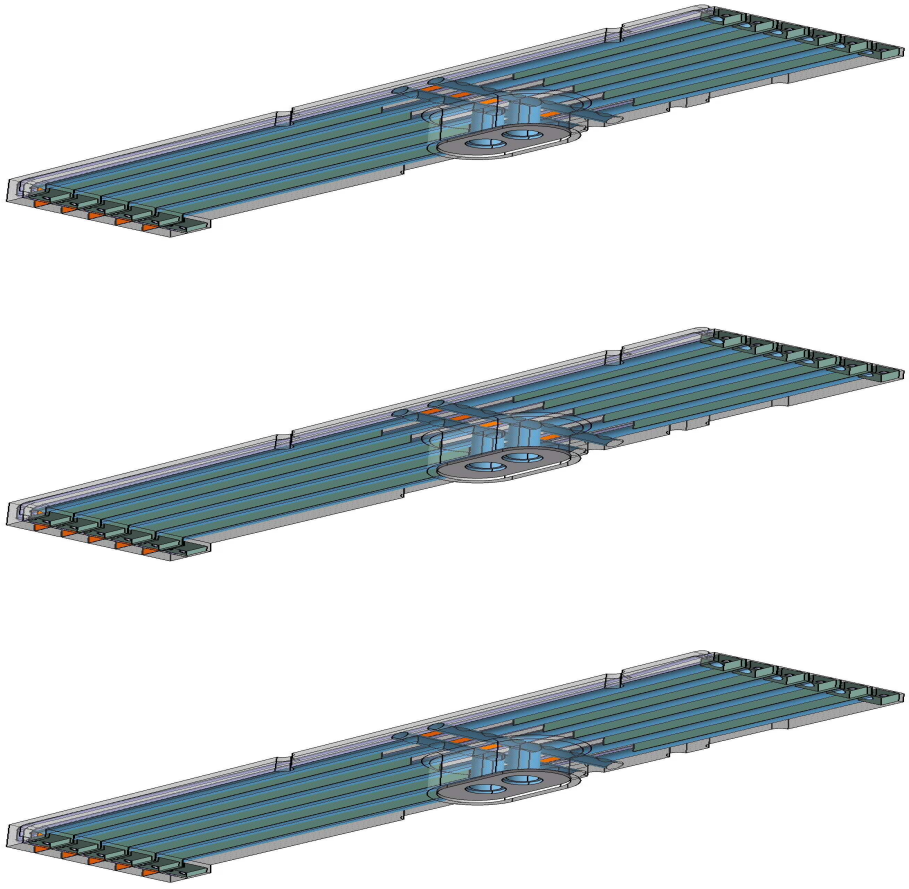
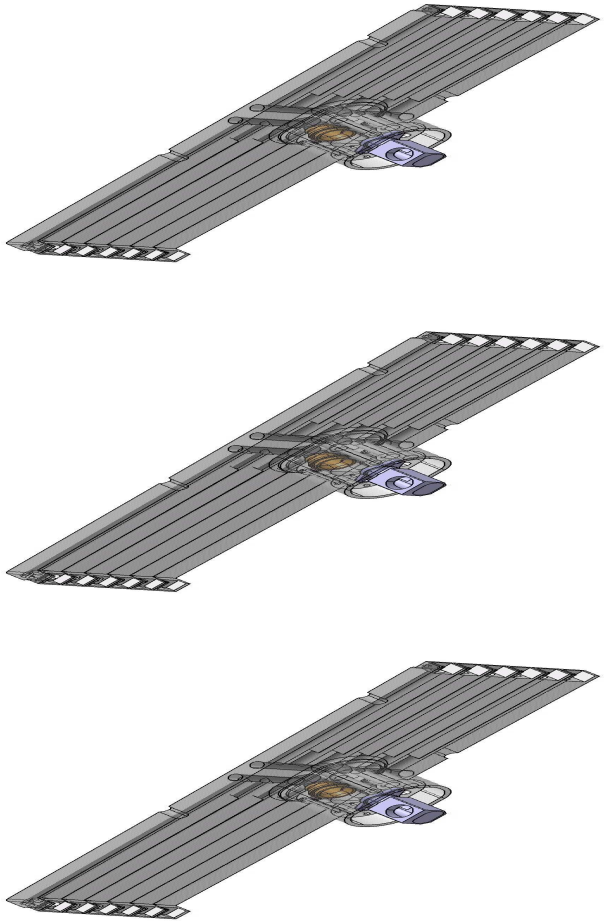
First Wall layout



First Wall layout



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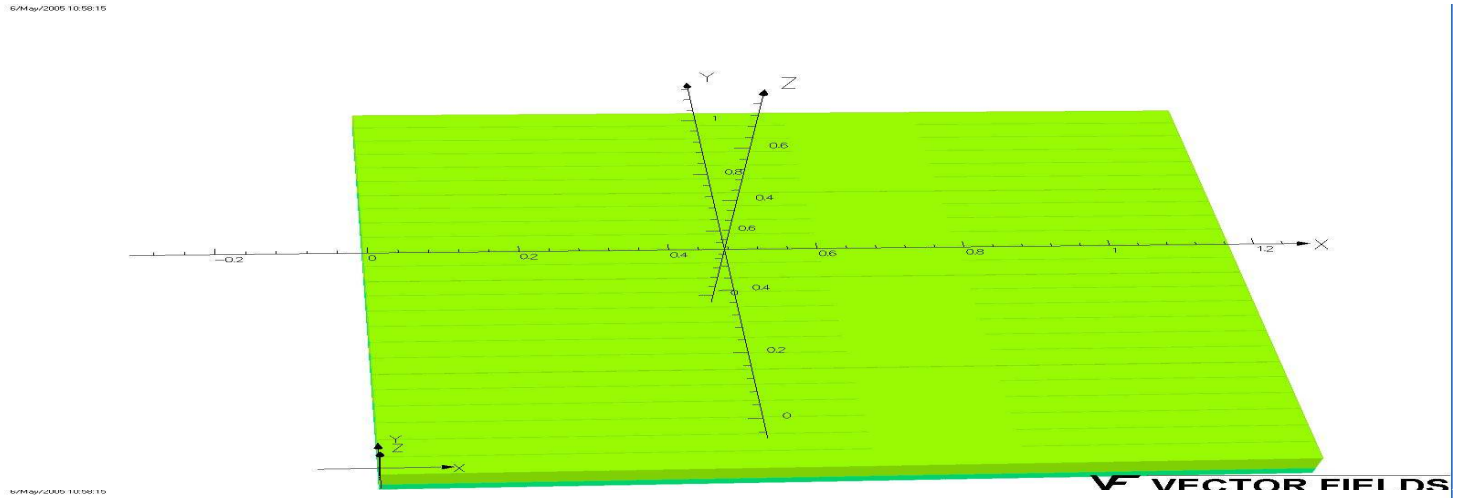
First Wall Thermal Analysis

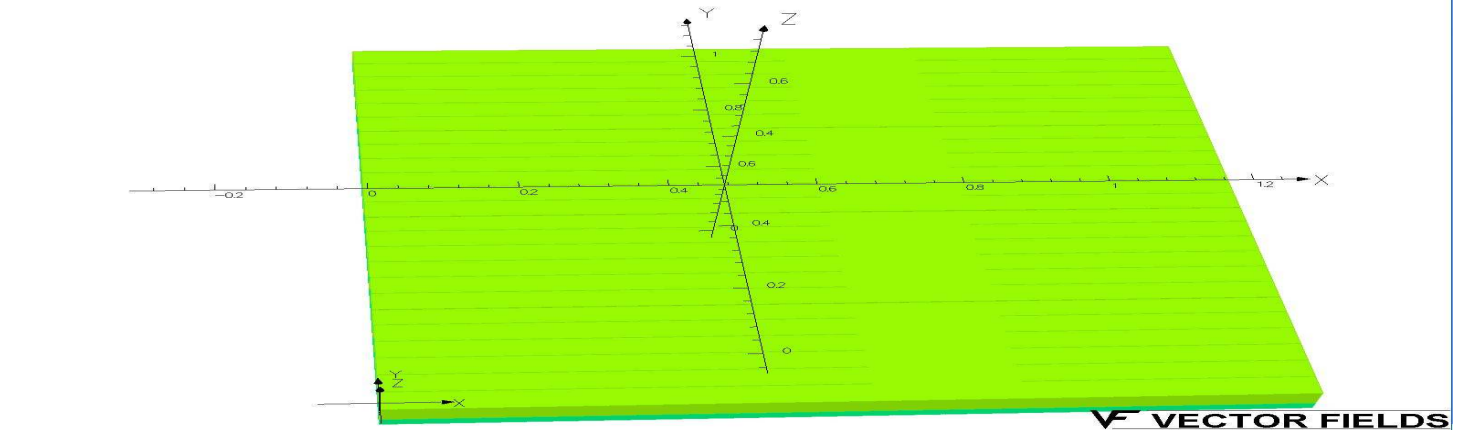
- The delta T across 10 mm of Be at 50 W/cm2 is 28C
- The temperature rise in the Be and Cu due to nuclear heating is negligible.
- At the normal operating point the Be has the capability of absorbing up to 18.4 J/cm2 without melting.
- The temperature rise in the 316 LN is discussed earlier.

First Wall EM Analysis

- A simplified model of the first wall was made for EM analysis while design details were worked out
  - Rectangular only (no trapezoidal taper)
  - All fingers equal
  - No support stalk
- EM analysis showed forces trying to twist the fingers and torque about the stalk
- A more realistic tapered model is being constructed

Simple FW





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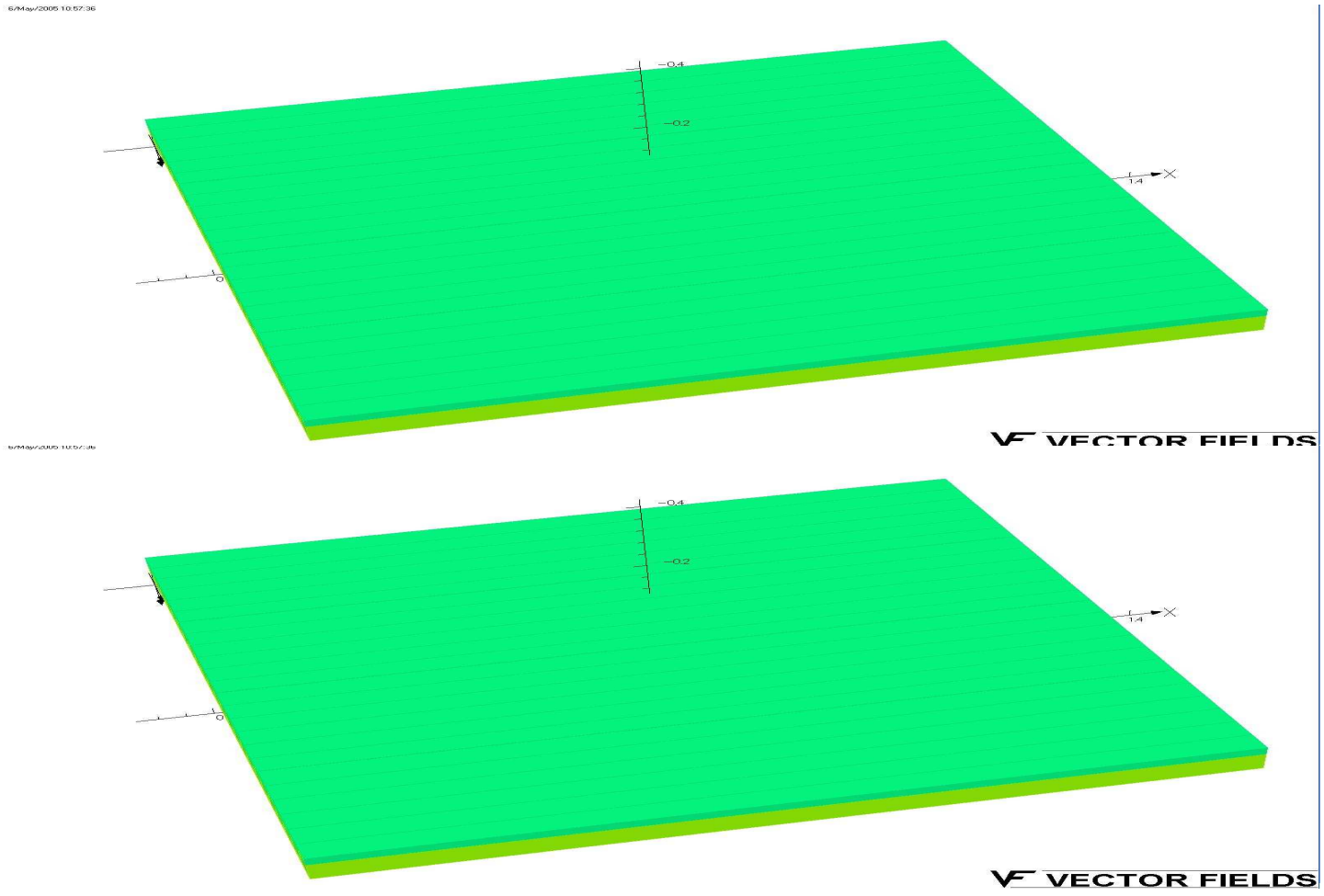
Simple FW



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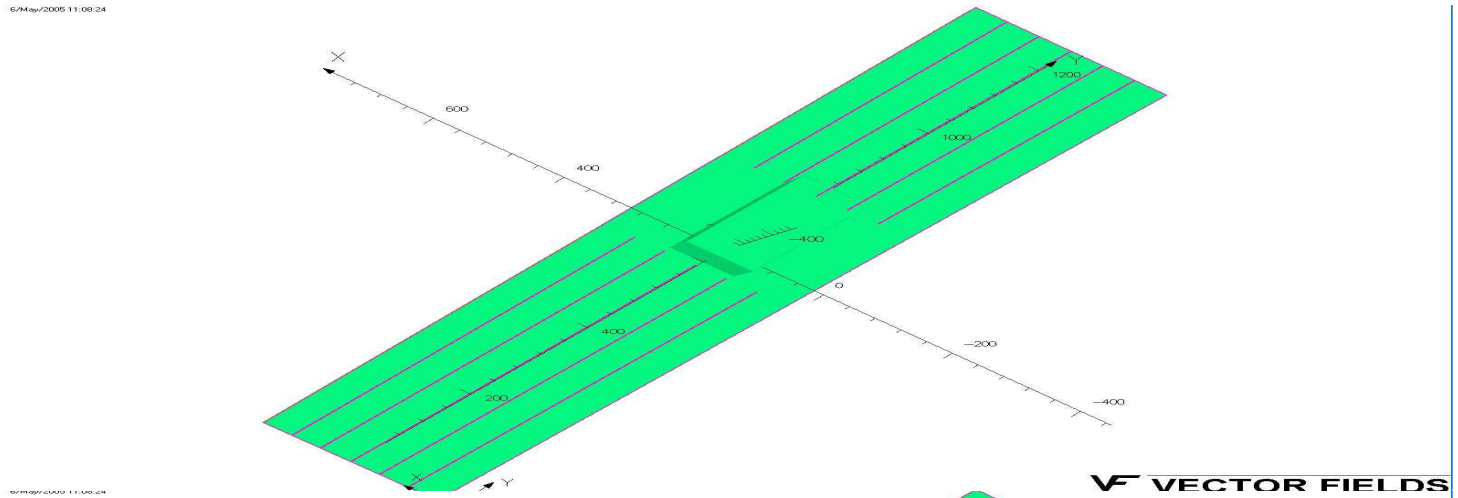
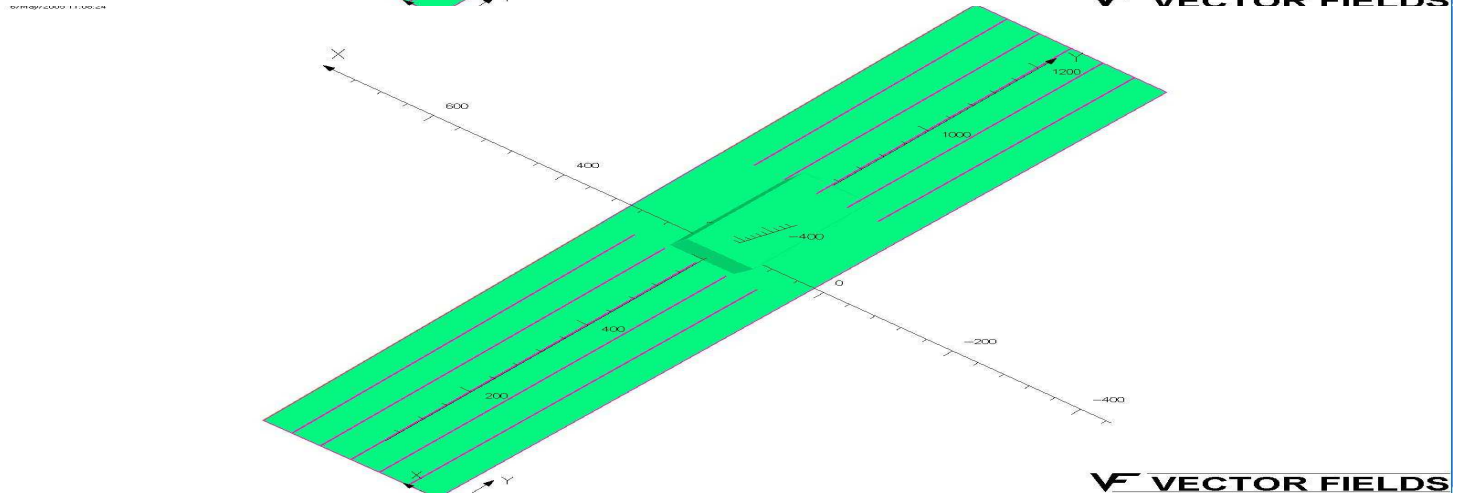
Tapered FW





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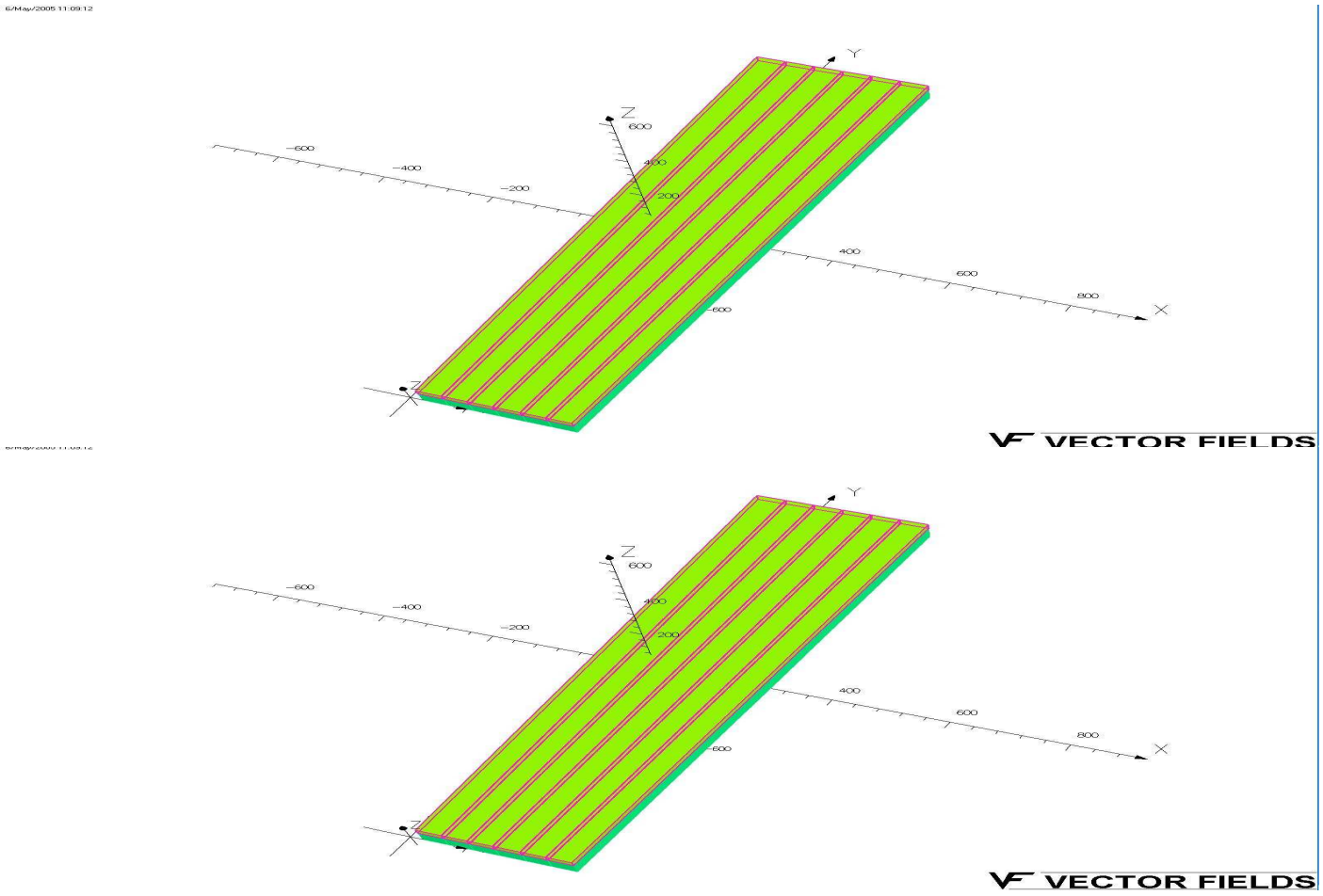
Tapered FW



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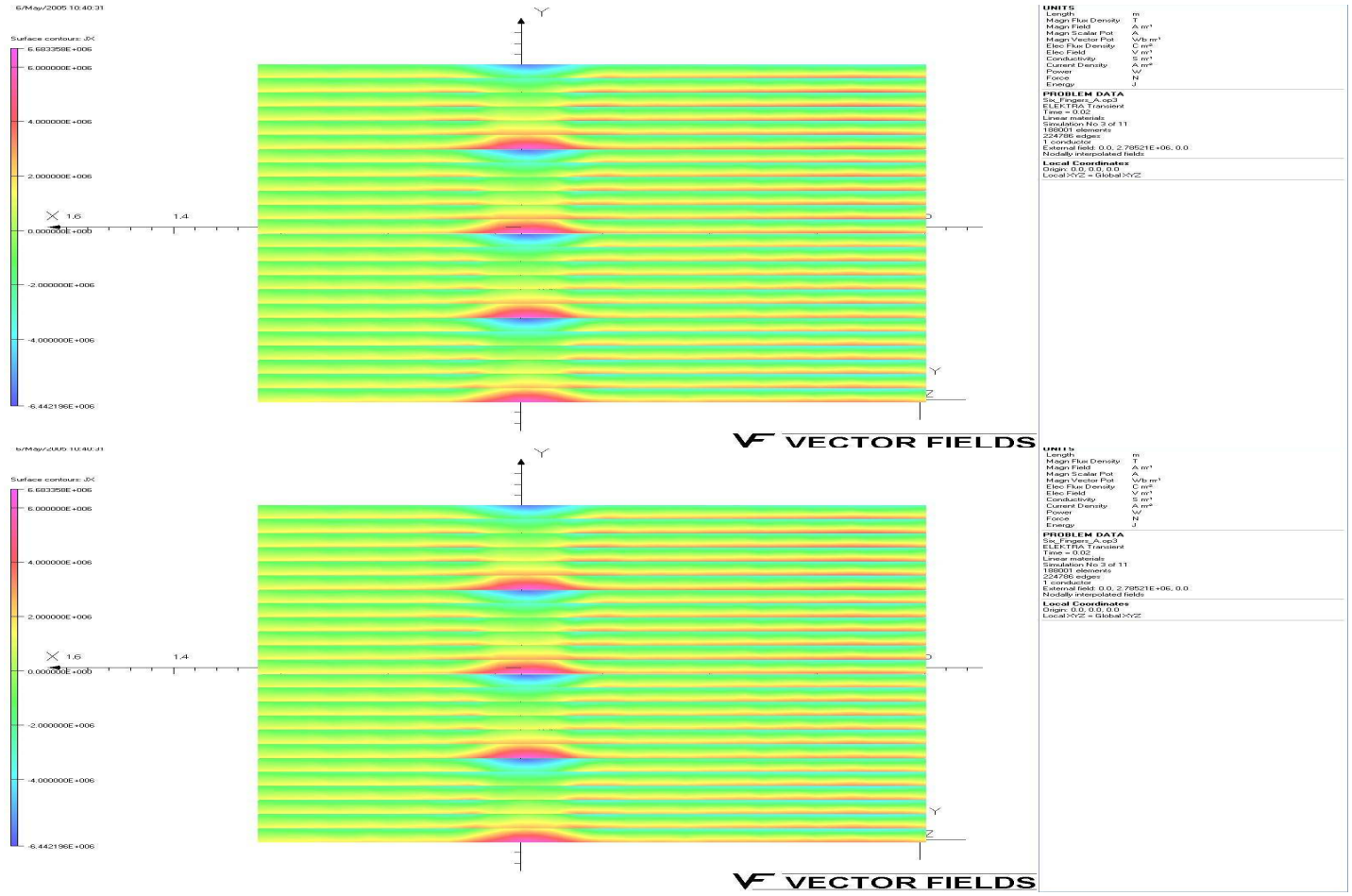
Current in the First Wall



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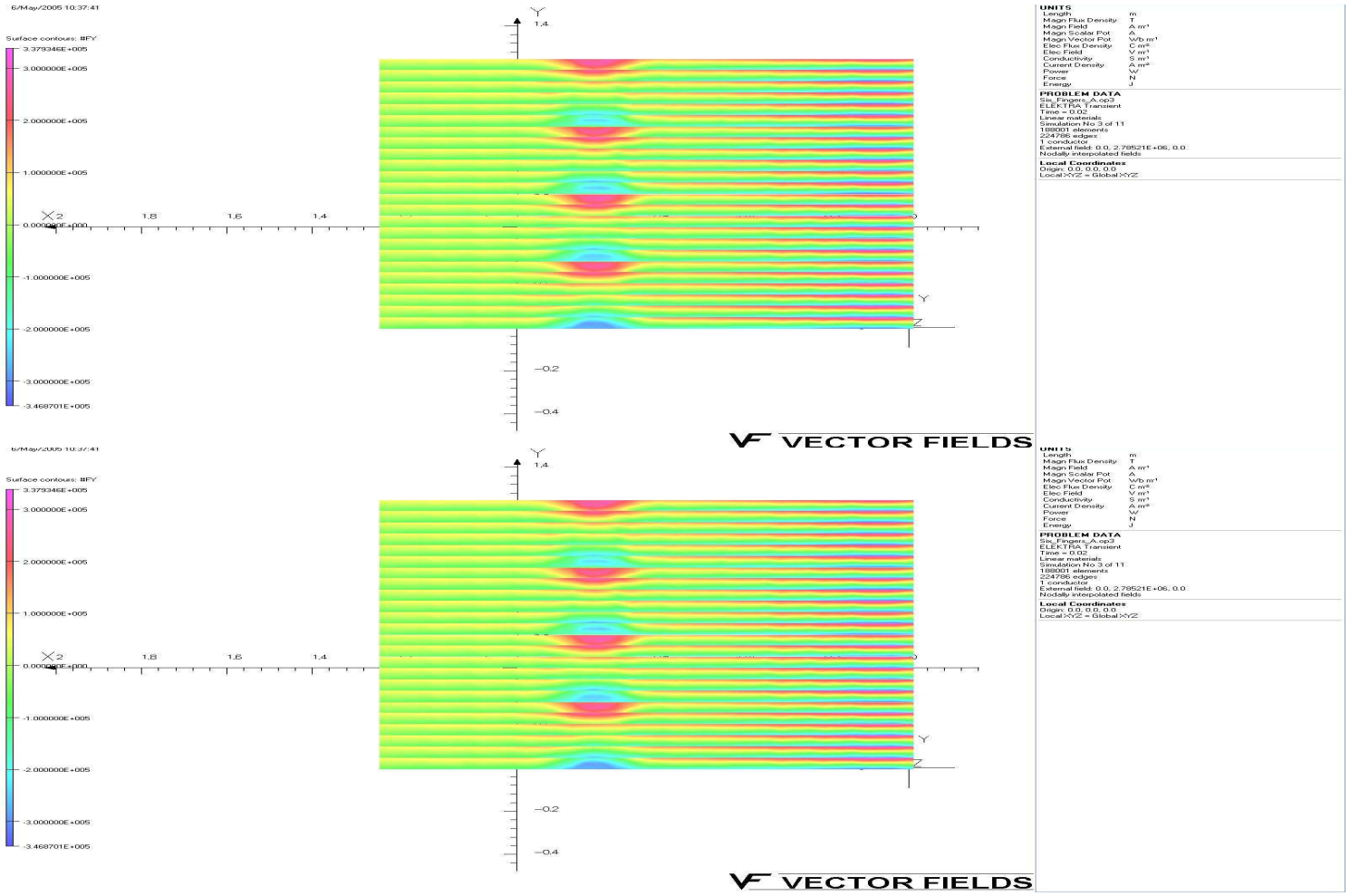
Force on the First Wall



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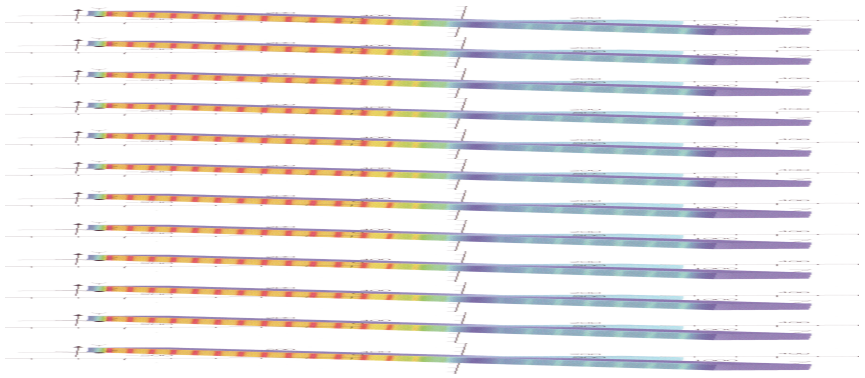
First Wall Halo Current Simulation

- The current flow capability of OPERA has been shown to be able to simulate halo currents in the FW
- The halo currents flow in the copper layer until they get close to the stalk where the flow switches to the stalk.
- Further refinement of the model is required.



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Issues to be Resolved

- Division of the FW into panels
  - The IT appears to be changing the FW design without complete analysis
  - Over hang of the FW beyond the shield is TBD
- Nuclear heating of the 316 parts appears to be too large. Cause? Solution?
- Pressure drop in shield may be too large (redesign)
- R&D is needed on fabrication methods